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ATTEMPT

TO

ASCERTAIN THE CAUSE

OF THE

EXTENSIVE INFLAMMATION,

WHICH ATTACKS

WOUNDED CAVITIES

AND THEIR CONTENTS.

BY JAMES COCKE,
OF VIRGINIA.

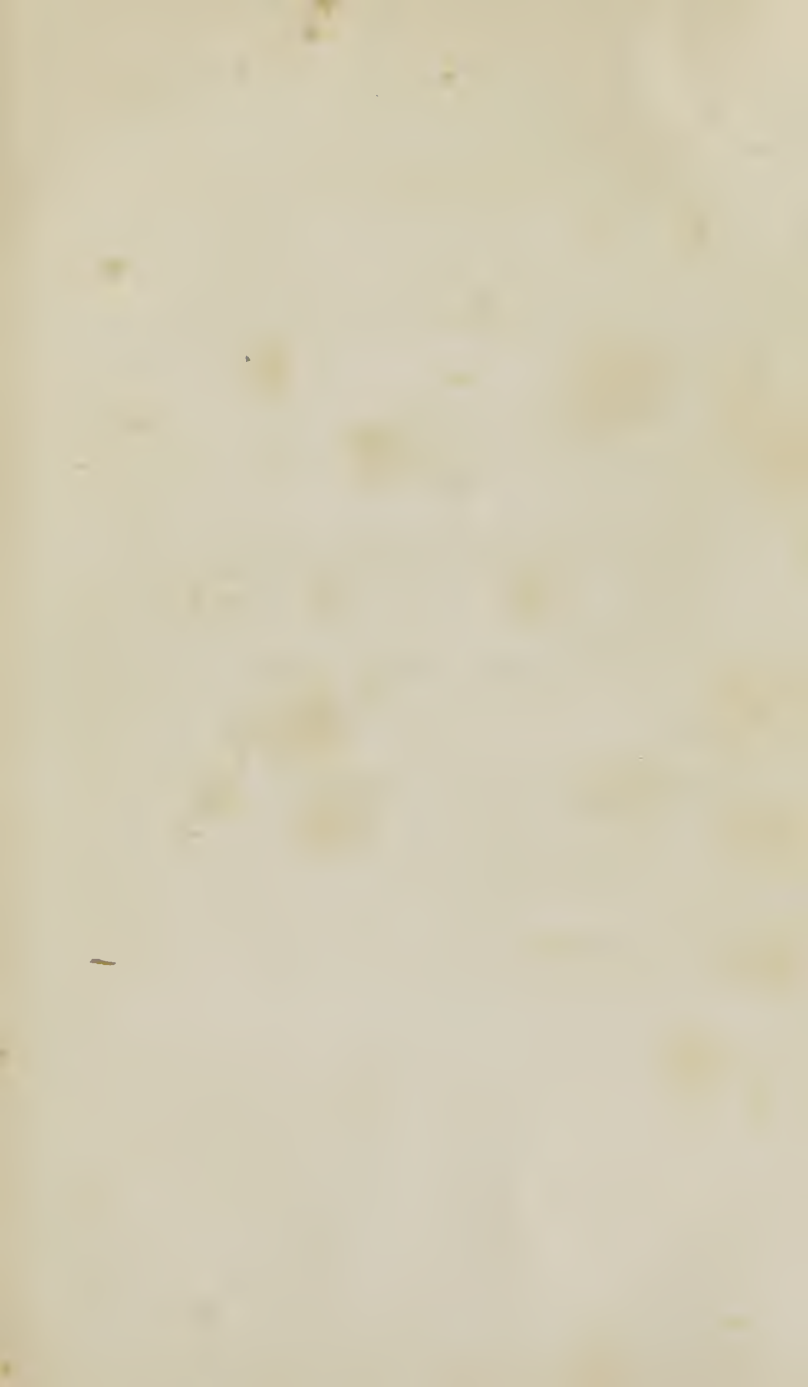
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MLM

AN INAGURAL ESSAY,
FOR
THE DEGREE
OF
DOCTOR OF MEDICINE;
SUBMITTED
TO THE EXAMINATION
OF THE
REVEREND JOHN ANDREWS, D. D. PROVOST,
(PRO TEMPORE ;)
THE
TRUSTEES AND MEDICAL PROFESSORS
OF THE
UNIVERSITY OF PENNSYLVANIA.
ON THE 5th DAY OF JUNE, 1804.



BENJAMIN RUSH, M. D.

*Professor of the Institutes and Practice of Medicine
in the University of Pennsylvania, &c.*

DEAR SIR,

IMPRESSED with the highest respect for your professional talents, I claim, as your pupil, the privilege of dedicating to you, my Inaugural Dissertation.

I am, however, more strongly impelled to it, by a knowledge of the many amiable and estimable qualities, which distinguish you, in your private and domestic relations; and which secure the affections of all, who have the pleasure of a constant intercourse with you.

I should, indeed, be insensible, sir, if I could leave this institution, without making the most grateful acknowledgements of the singular advantages which you have afforded me, as my public teacher, my private preceptor and my faithful friend; the recollection of which, will ever be pleasing to,

Your much obliged,

Pupil and Friend,

JAMES COCKE.

MAY 19th, 1804.

ASTLEY P. COOPER, Esq. F. R. S.

*Surgeon of Guy's Hospital, Lecturer on Surgery,
and adjunct teacher of Anatomy, at St. Thomas' Hospital, London, &c.*

IF it were possible for me to request it, your politeness, dear sir, would insure me permission, to prefix your name to this Essay. I think it fair, to avail myself of your protection, as one of my teachers in surgery; And particularly on this subject, to which my attention was attracted, by your practice and lectures.

Should the doctrine which I advocate, be just, and the practice which it suggests, be correct; I do not know any person to whose candour and liberality, and zeal for the improvement of surgery, I would sooner commit its defence, than to yours; as I know you to be incapable, of rejecting any opinion, simply because it is first advanced at a foreign University, and defended by a student of Medicine.

Allow me now, sir, to return you my thanks for the uniform civility, and kind attention with which you favored me, during my residence in London, and to assure you of the high respect with which I am,

Your Obligated Friend, and

Most Obedient Servant,

JAMES COCKE.

MAY, 19th, 1804.

AN INAUGURAL ESSAY, &c. |

IN deciding on a subject for a dissertation, much difficulty presented. The great variety of diseases, which are interesting to physicians, have already attracted the attention, and exhausted the ingenuity, of other candidates for medical degrees. Independently of their productions, all diseases have been treated of, by medical writers of the greatest note, on whose descriptions and modes of practice, I could not have flattered myself, with the hope of making any improvement.

I have been induced to institute this enquiry, into the cause of the extensive inflammation which takes place on wounded cavities, not only, from a consideration of the contrariety of opinions, which prevails among surgeons, on this subject, but by a hope, that I might bring into view, a source of this inflammation, which I think the true one, although it has heretofore escaped notice.

In the progress of this essay, I have been obliged to take a short review of the doctrines of the principal writers, who have touched on this subject. I hope I have succeeded in quoting their opinions fairly; and that I have in no instance, forgotten the respect, which is due to those, who have laboured to enlighten, and alleviate the miseries of, mankind.

The greater danger, of wounds penetrating into the cavities of the body, than of wounds of equal extent in other muscular or membranous parts, must have been noticed by the earliest practitioners of surgery. But, al-

though the fact has been so long known, and admitted, by all writers who have mentioned the subject, no satisfactory explanation of it, has yet been given.

An occurrence so frequent, so obvious, and so interesting, as the violent inflammation, which takes place on wounded cavities and on parts contained in them, could not fail to attract the attention of pathologists, and it has been attributed, by those of the highest credit, to different causes. None of their theories have, however, been so supported, as to gain general credence, and every surgeon embraces that, to which accident, prejudice or reflection has inclined him.

I shall not attempt to detail, all the hypotheses which have been advanced by authors, with a view of explaining it. Some of them, from the high authority by which they have been introduced, and from the ability, by which they have been urged; demand particular attention. However opposite and contradictory the opinions of writers have been, as to the cause of the dangerous symptoms which supervene on a wounded cavity, no one has questioned the importance of ascertaining it, as it is evident that a discovery of it, would lead us directly to the most rational way of preventing them.

It appears to have been the opinion, generally received, from the most remote period of medical history, that atmospheric air has an injurious effect, when admitted into contact with parts, which are naturally defended from it. The opinion was simply announced, and as inflammation was always extensive, when any cavity was opened, and a communication with the atmosphere established; the air being the only foreign matter which could possibly insinuate itself, it seemed natural to conclude, that it was the offending cause; from this circumstance, I presume, the doctrine of the deleterious properties of air took its rise, and this theory the most universally acknowledged, appears for a long time to have been deemed incontestable, although entirely unsupported, except by a slender probability and the

respectability of its advocates; nor do I find that any writer had ventured to oppose it, untill within a few years.

This ancient and common opinion was adopted, extended and inculcated by Dr. Monro, who enters largely into the investigation, "Of the cause of the dangerous inflammation which generally follows the wound of a shut sac, and of the manner of preventing it."*

Influenced, by a consideration of the difference between simple and compound fractures and dislocations, by the results of a number of experiments which this author made, and by the issue of some cases, in which air was supposed to have had access to the cavities of joints, he concludes that the inflammation, which takes place on wounded cavities, as well as that following some of the principal operations in surgery, is chiefly owing to the admission of air, to which he appears to attribute highly stimulating powers.

That this very respectable writer was deceived, by taking only a superficial view of the subject, may, I think, be easily shewn. In the common accident of a fracture of the ribs, with a laceration of the lungs, the cavity of the chest is filled with air, from whence, it escapes into the cellular substance on the thorax, and is thence diffused through the cellular texture over the whole body; in these cases, unless the integuments are wounded and a communication made externally, no great inflammation is the consequence; although air in abundance is applied to the cavity of a shut sac, to a surface unaccustomed to its action, and on which it is said to produce highly stimulating effects: In what way has it here been rendered inert? and, why is it not uniformly followed by its supposed ordinary consequence?

Some experiments have been made by Mr. Astley Cooper, to decide, whether air is stimulating to internal surfaces. I do not know the particular manner in which they were performed, but from the known accuracy and ability of that gentleman, I have no doubt, of their having been conducted fairly, and of their having borne strongly

* Monro's Description of all the Bursæ Mucosæ, of the human body, p. 39.

and directly on the point, which he wished to ascertain : The result was, a conviction that air does not stimulate.

I am unable to determine, whether the pressure on the contents of the abdomen, by the diaphragm and abdominal muscles, is so uniform, as to exclude the air entirely from that cavity when wounded, as has been asserted by Mr. John Bell; but as that cavity contains the intestines, filled frequently with flatus only, and composed of thin and yielding coats, it seems equally probable that air should get access to this cavity, as to that of the chest, filled with the lungs; which are well known, to be some times oppressed by air, entering through wounds of the breast. As a proof, that the cavity of the abdomen is replete with its contents, Mr. Bell observes, that hernia is frequently produced, by a blow upon the belly or by any sudden exertion.* That either of these, may be the cause of hernia, I am well aware, as a blow on the abdomen, may be given in such a way, as to make the bowels press violently on all sides; and if there is a weak part, it will yield, and some of the contents will be forced out of the cavity. On the same principle, a bladder, nearly filled with water, will burst, when forcibly stricken. That the abdominal muscles are capable of contracting so violently, as strongly to compress the bowels and to produce a rupture, cannot be disputed; but it is not more correct, to suppose the muscles of that part to be in their common state, thus contracted; than it would be to calculate that the gastrocnemii muscles are always acting with great force on the Tendo-Achillis, because they sometimes act so powerfully, as to rupture it.

If this pressure were so extreme and unremitting, the bowels would not be able to perform their functions; and the large and undefended vessels, especially the veins, would have their circulation arrested. One great source of alarm to Mr. Bell, is certainly ideal; he apprehends that the blood vessels of the abdomen would burst, if not supported, by pressure on the surrounding bowels. That these vessels can bear unaided, the weight and momentum of the blood,

* Bells Discourses on wounds, part II. p. 71.

is fully proven by their sustaining no damage, after childbirth or the discharge of large collections of water in abdominal dropsies. In neither of which cases can the flaccid parietes of the abdomen be supposed to have any influence on them.

THE doctrine of air stimulating internal surfaces, during so long a period almost universally acknowledged, has been subjected to a close and severe examination by some late writers. As just and weighty objections could be adduced against it, it has been rejected, and attempts made by Mr. Hunter, Mr. Abernethy and Mr. John Bell each to substitute his own in the place of it.

The genius and celebrity of Mr. Hunter, as might have been expected, have engaged many of the most respectable surgeons of the present time, in favour of his opinion. The high respect which I entertain for the talents of these gentlemen, some of whom I have been accustomed to view, with that partial regard, which results from a sense of benefits conferred, of which I hold instruction to be the greatest; and the veneration which I feel for the character of Mr. Hunter, induce me to hesitate when I think of attempting an examination of his theory, and of pointing out any mistake, into which, from the multiplicity of subjects engaging his attention, and the vast extent and importance of his discoveries and improvements in physiology and surgery, he may have fallen, in some points of inferior moment. Nor should I undertake it, if I were not compelled to write, and at the same time fully persuaded of the inaccuracy of his doctrine on the subject of this paper.

“In many cases of the emphysema, where the air is diffused over the whole body,” says Mr. Hunter, “we have no such effect, (as inflammation) *and this air not the purest*, excepting there is produced an exposure or imperfection of some internal surface for this air to make its escape by, and then this part inflames. Nay, as a stronger proof, and of

the same kind with the former, that it is not the admission of air, which makes parts fall into inflammation, we find that the cells in the soft parts of birds, and many of the cells and canals of the bones of the same tribe of animals, which communicate with the lungs, and at all times have more or less air in them, never inflame; but if these cells are exposed in an unnatural way, by being wounded, &c. then the stimulus of imperfection, is given, and the cells inflame, and unite if allowed; but if prevented, they then suppurate, granulate &c.”*

These are the chief grounds, on which Mr. Hunter has introduced the new, and to me, incomprehensible doctrine of the “stimulus of imperfection;” which appears to have been assumed, without the semblance of proof, or any arguments shewing even the probability of the existence of any capacity in the animal economy to give it. It is, indeed, very certain that all wounded cavities are imperfect, and this being a necessary and unavoidable circumstance and uniformly attending; as it applies to every case, is, with perhaps something more of the appearance of truth, charged with the consequent inflammation, than air, which had before been suspected.

Mr. Hunter is not explicit as to the source of the *stimulus of imperfection*; nor am I certain, whether he intended to convey the idea, that it is given by an intelligent agent, but from the manner in which he speaks, he must have viewed it, as arising from some power capable of deciding when such a stimulus is necessary, directing its efforts to the benefit of the system and instituting such actions as are necessary to restore parts that are injured.

If this doctrine were in every other respect satisfactory, the introduction of this single term, which I am unable to familiarize to myself, by the substitution of any simple expressions, would be sufficient cause with me, for its total rejection; as well might we admit, the volition of nonentity, in Metaphysics. But, I am still more unwilling to

* Hunter on Blood, vol. II. p. 98.

admit Mr. Hunter's terms, from a recollection of the extensive injury, which science has heretofore sustained from theories, requiring the aid of imaginary intelligencies, to explain the operations of the human body, both in health and disease. They paralyzed investigation, and appeared to render superfluous, the researches of the physiologist and pathologist, farther, than to trace causes to that point, at which, these agents might be supposed to commence their action.

Whether the cells in the soft part of birds, and the cells and canals of their bones are liable to become inflamed, from the alternation of heat and cold, I am not certain. But, as other animals beside man, particularly the horse, are subject to catarrhal affections, by passing suddenly from a low, to a high temperature of air, I think it entirely probable that these cells and canals, which are parts of the respiratory apparatus of birds, may also under similar circumstances be inflamed.

Other considerations however, have weight with me, as they shew the inadequacy of this theory. Emphysema, the very affection, on which, Mr. Hunter has in a considerable degree, rested his conclusions, against the supposed effect of air in inducing inflammation, is intirely apposite to my purpose and contributes largely to disprove his doctrine. It shews that inflammation does not always occur to any considerable degree, from a cavity being rendered imperfect, and remaining so for some time; which frequently happens, when, from a fracture of the ribs, one lung and both sides of the pleura are torn, and a communication with the external air remains for several days; and in such cases it cannot be denied that the cavity is imperfect; both by a communication through the lung, trachea and mouth; and also, by a laceration of the pleura costalis and intercostal muscles, giving passage to the air, into the cellular membrane on the trunk. Whence it is diffused over the whole body, which latter circumstance alone, seems sufficient to warrant the cavity being called imperfect.

When a wound is made into any of the cavities of the body, the abdomen for instance, every part of that cavity, as the integrity of the whole has been affected, should, according to the doctrine of Mr. Hunter, feel the stimulus of imperfection, and take on that action, which this stimulus is suited to excite. But generally, a portion of intestine, is protruded through the wound, and in a short time we perceive the peritoneum, which covers this piece of intestine, becoming more vascular, and incipient inflammation taking place on it; while every other part of that cavity is entirely free from inflammation. Surely no good reason has been assigned, why a general cause should produce an effect so partial, nor does any explanation by the author of this doctrine occur to me, unless the stimulus of necessity is brought into action, which may be said, to induce the inflammation, with the intention of rendering the cavity perfect, by producing an adhesion between the lips of the wound and the surface of the protruded bowel. But as the admission of this extraordinary agency, would be perfectly gratuitous; I think it proper, to adopt a mode of accounting for these occurrences, which seems to be founded on a firmer basis.

The utility of the inflammation which takes place on the surfaces of wounded cavities, will not, I believe, be questioned, nor will it be affected if shewn to arise from a law which pervades all animated nature, and not to be under the guidance of an intelligent principle or *anima medica*.

THE inflammation, which generally follows the evacuation of matter from an abscess, and which, uniformly occurs in cavities that are laid open, could not escape the observation of Mr. Abernethy, who, ever close in his investigations and cautious in his conclusions, found it necessary, to abandon the theories which had been advanced by others, and to propose a more plausible one, which, attri-

butes the inflammation to the *frequent renewal* and the *long continued* application of air, to a surface unaccustomed to it.

To this opinion of Mr. Abernethy, however, an objection presents itself. Although under ordinary circumstances his explanation may, and I believe will, be found to be *literally* true, yet, I am certain that his intention was to inculcate the doctrine, that air, when frequently renewed and long continued, acts on internal surfaces as a stimulus; which meaning, may be fairly deduced from his words; “a constant renewal of air is permitted, and the application of a matter so unusual to these surfaces, I am inclined to believe does harm.”* Which doctrine, I think will not prove to be correct, as I am led to believe from a consideration of the mildness and pleasantness of air, when applied under certain circumstances, either to the internal or external surfaces for any length of time, and from an assurance, on high authority, that it is not stimulating to the animal fibre.

OF the various theories which have been proposed on this subject none has been more confidently advanced, than that of Mr. John Bell of Edinburgh. He assures us, that the “inflammation running so quickly round all the surfaces of shut sacs, wherever they happen to be wounded, proceeds altogether from another cause, (than air) simple and plain to the last degree. For, in the wound of any shut cavity where the parts do not adhere, the inflammation spreads and runs its course, by a law of the animal economy, which we explain very ill, when we call adhesion the adhesive stage of inflammation, representing, as the first stage of a most dangerous disease, that adhesion which is a natural and healthy action, the most natural in all the system and the farthest from disease.”†

* Abernethy's Essay on Lumbar abscess p. 55.

† Bells Discourses on Wounds, Part II. p. 93.

Simple and plain, as the cause of *the rapid progress* of inflammation in cavities, appeared to this ingenious surgeon, it is certainly to be regretted that he has not dispelled the darkness which to the view of most others, still rests upon this point.

The ideas of Mr. Bell, as to the *cause* of the *inflammation*, are more clear and accessible. "It is plain" he says, "that inflammation, or the absence of it, arises not from the presence or absence of air, but from the length of the incision, there is no inflammation where the wound is small, though it is made on account of confined air; there is inflammation where the incisions are large, though they are made with the intention and also with the effect of letting loose the confined air."*

I am entitled by a variety of circumstances to deny, that the membranes lining cavities, are liable to become inflamed from slight mechanical injuries. In a number of experiments performed by Dr. Monro; he found that the inflammation was never in proportion to the size of the wounds made into the cavities of animals, but that it corresponded, with the time and manner of the exposure of the bowels to the air.†

The capability of membranes lining the cavities of joints to bear violence without great inflammation, is shewn in all cases of dislocations, where the capsular ligaments and consequently the lining membranes are lacerated: Similar hardness is evinced by the pleura, which must frequently be considerably torn, by the rough ends of fractured ribs, and yet we see persons in whom it has happened, recovering without any of the symptoms of thoracic inflammation.

Inflammation from local irritation is generally proportioned to the extent of the injury, which is certainly not the case in wounds of cavities, the lining membranes of which, are sometimes extensively lacerated and no inflam-

* Bells Discourses, Part II. p. 90.

† Description of the Bursæ Mucosæ, p. 45.

mation follows, while in other cases, the most alarming inflammation supervenes on a cavity, wounded only by a small puncture. Irritation from wounds, on which Mr. Bell lays so much stress in that discourse, in which he treats of inflammation of cavities, will not explain, why inflammation immediately takes place, on any portion of intestines, protruded through a wound of the abdomen. It surely will not be said, that the irritation or inflammation of the wound, has been communicated to the bowels by Mr. Bell's *sort of contagion*, and thus propagated over the whole of the peritoneum covering them.

If the inflammation of cavities were caused by the irritation of wounds, it would be expected to spread gradually from the wounds to the nearest portion of the lining membrane, and in a regular way to travel over the whole surface, which does not take place. But if any of the contents of a cavity are exposed, they immediately inflame over their whole surface, leaving in a sound state all that extent of lining membrane which intervenes, from the wound to the part protruded. In some cases, the inflammation of the intestines cannot be supposed to have the slightest dependence on, or the most remote connection with, the irritation of the wound. Of which, two experiments, made by Mr. Hunter with other views, furnish striking proofs. In one of these experiments, the surface of the testicle of a young ram, being exposed, became almost immediately more vascular, and in an hour or two discharged matter, different from that which is generally found on its surface. In the other, the cavity of the abdomen of a dog was laid open by an incision of several inches long; in five minutes, the increased action of the vessels of the cavity, had altered, and augmented the quantity of, the lubricating matter; in fifteen minutes the surface was apparently more vascular, and the appearance of the secretion still more changed. "The spleen" (and I suppose the other viscera) "had its surface excessively red, from the increased number of small vessels carrying red blood. From these appearances"

says Mr. Hunter, "the fluid which lubricates the peritoneum seems to undergo changes, in consequence of exposure, and at last, when inflammation takes place, to have coagulating lymph substituted for it."*

Before we can suppose this instantaneous effect to be produced by the irritation of the wound, it will be necessary to conceive, that its velocity is nearly equal to that of the electric fluid, and to attribute to it a power more extraordinary, that of inducing inflammation on one part of a surface, passing over that which from its continuity should next be affected, and seizing on another, and more distant part.

The irritation, from the puncture of a lancet, or even an incision, cannot be compared with that which is given to the tunica vaginalis testis, when a caustic has been applied to it, for the cure of hydrocele; by which application, that membrane, suffers all that it can do, from irritation, yet the inflammation is inconsiderable until the tunic has ruptured.†

If irritation from a wound or puncture were alone, sufficient to produce fatal inflammation; the violence done, by an incision made into the abdomen and uterus with the fragment of a butcher's knife, in the case related by Dr. Moseley and noticed in another part of this paper could not have been survived.

It is not my design to deny that irritation is the consequence of wounds, for I believe there is no wound, however slight, which does not produce some degree of irritation, but, I think we have ample grounds for deciding, that local irritation from a wound is incompetent to the production of inflammation so extensive as that which follows a wound into a cavity.

* Hunter on the Blood, Vol. II. pages 144. & seq.

† Abernethy's Essay on Lumbar Abscess, page 56.

AT a time, when cold was supposed to be actual matter, and thought to be a stimulant; there could have been no difficulty in giving a plausible solution to the question, of the cause of the inflammation which attacks internal parts, when exposed to the open air; as the air is generally below the temperature of the body. Cold had stimulating powers attributed to it, from pain, redness and inflammation of the skin having been observed to follow exposure to it, and by the system having been observed to be strengthened by the application of it, in a certain degree.

That the privation of an accustomed stimulus will produce pain is well known, and the violence of the pain will be in proportion to the extent and continuance of the diminution, within certain limits. This pain when caused by cold, arises from the actions of the exposed parts, being lessened and performed irregularly, but pain from exposure to cold, is not very violent, until a higher temperature is applied. The manner in which it is then produced, will be noticed in another place.

That cold is not a stimulus is shewn by the weakness, torpor and death which are produced by its long continued application, by the effect which it has on the pulse and by its use in diseases of too great excitement.

The increase of strength, said to be produced by cold, as in the cold bath, does not appear during the application of cold, and is entirely owing to the disposition of living matter, to become more sensible to its common stimuli, after they have been withheld for a short time. Which disposition does not shew itself in those cases only, in which heat has been applied, after its abstraction for some time; but its effects are almost as striking in cases where persons have fasted for a long time. Some of the company of captain Bligh felt the symptoms of intoxication from eating oysters, and some berries of an innocent nature, after they had for several days eaten a very small portion of food. Dr.

Percival mentions a young physician of Geneva, who, when a student at Montpelier, fasted three days, after which, the first nourishment he took was veal broth, and that had an intoxicating effect on him.

AS all the above mentioned theories, appear in some part, either defective or inapplicable. I shall make an attempt to account for the inflammation which occurs on wounded cavities and their contents, in a manner, which has received the sanction of no surgical writer. But I hazard it, at present, with extreme diffidence, both on account of the hasty manner in which I am compelled to advance it, and the slight support, which, a very limited time allows me to derive from experiments, or from medical and surgical writers.

Before I proceed to suggest my ideas of the cause of inflammation supervening on wounded cavities, it must be observed that inflammation may be produced, 1st. By preternatural stimuli acting on a part possessing only its due proportion of excitability, in which consists its health; instances of this are afforded by cantharides, some chemical preparations, heat of 212 degrees, &c. applied to the sound skin. 2ndly. It may be produced by ordinary stimuli acting on a part, the excitability of which has been accumulated by a temporary suspension of their action, which may be noticed in parts of the body which have been exposed to a great degree of cold; it is also observable in catarrhs and some species of cynanche.

The effect of cold in rendering animal bodies more sensible to heat, or incapable of bearing so high a degree of it, must soon have been learned from experience, by the inhabitants of cold countries; and although they probably possessed no correct theory, as to its mode of action, they did not neglect to avail themselves of their knowledge in practice, as is shewn by the mode which

they adopt, to recover persons who have suffered from exposure to violent cold.

That cold has the effect of making parts more sensible to heat subsequently applied, has been noticed and illustrated by Mr. Hunter, whose phraseology, when treating on this point, is new. He supposes the quantity of life to be lessened by cold, and says, stimulus must be proportioned to the quantity of life.

He says farther, "Cold, according to its degrees, produces two very different effects, one is the exciting of action without lessening the powers, the other is absolutely debilitating, while at the same time it excites action, if carried too far; in the first, it becomes like suitable exercise to the vascular system, as bodily exercise is to the muscles, increasing strength; but when carried or continued beyond this point, it lessens the powers and becomes a weakener, calling up the action of resistance after the powers are lessened."....Again,

"Cold produces the action of contraction in the vessels, which is an action of weakness. A degree of cold suddenly applied, which hardly produces more than the sense of cold, excites action after the immediate effect is over, which is the action of dilatation, and which is the effect of the cold bath when it agrees; and as cold produces weakness in proportion to its degree, its application should not be carried too far, for then it produces a much worse disease, irritability, or over action to the strength of the parts, and then indolence too often commences."*

Between the doctrine advanced in this extract from Mr. Hunter, and the opinion of Dr. Brown on the same subject, I perceive no particular difference, except in terms. They both allow that the effect of cold applied for a short time is the exciting of action, after it is withdrawn, or a higher temperature is given to it, which takes place on leaving the cold bath. When a part has been exposed for

* Hunter on the blood, vol. ii. p. 74.

a long time to a greater degree of cold, the disposition to action is increased so greatly as to have inflammation or gangrene brought on by ordinary stimuli subsequently applied, examples of which are frequently seen in frosted limbs.

It was, I believe, first taught by Dr. Brown, that all sedative powers, weaken the tone of the fibre, which by accumulating irritability predispose to inordinate action on the application of a slight stimulus. Cold, I think, is eminently intitled to be considered a sedative power. That it produces debility is shewn by the effect which it has on the pulse and on the skin, also by the general reduction of strength which is observable in those who are exposed to it for any length of time. Of this debility, I presume, an accumulation of excitability or by whatever name it may be called, an increased aptitude to be acted on, to be the uniform consequence. An instance of this debility from cold and consequent sensibility to heat, is shewn in the common cold days of winter on our hands and faces.—When we first leave a room, the temperature of which is pleasant, and go into the cold air, the exposed parts immediately become pale and remain so for a short time, after which, from an accumulation of excitability, lessened tone, or weakness of the vessels of the parts, the action existing in the system will be sufficient to throw blood enough into these parts to render them quite florid; and if we return to the same temperature, which had before been grateful to our feelings, or to one a little higher, the action will be so much increased, as to give considerable pain, and even to go on to inflammation and mortification.

It has been conjectured that when any part of the body has been weakened by cold, the adjacent parts sympathize with it, and, as soon as the cold is removed, the action of the neighbouring parts spreads to it, giving to it a greater degree of action than its weakened state can bear, of which, inflammation is the consequence, frequently terminating in gangrene.*

* Burns on Inflammation, Vol. I. p. 267.

It is not material to my present enquiry to ascertain, whether inflammation is induced by the sympathy just mentioned, or is the consequence of cold being applied beyond the powers of resistance of the parts, or is produced by stimuli acting on the accumulated excitability, which supervenes on debility. I incline, for various reasons, to the latter mode of explaining the phenomena, and one of the greatest weight, is, that it receives the support of all the arguments used by my preceptor Dr. Rush, in favour of his theory of fever; in either case, predisposing debility occurs, on this, an accumulation of excitability follows, on which any accidental additional stimuli, or even the ordinary stimuli will act with sufficient force to induce inflammation.

I think it strongly in favour, of the truth of the explanation which I propose, of some cases of local inflammation, that it accords so fully with the theory of fever of Dr. Rush, which has thrown light on various diseases, and led to innumerable improvements in medical practice.

As the temperature of the internal parts of our bodies, is always considerably above that of the surrounding atmosphere, whenever a direct communication is made between the cavities of the body and the external air; it is obvious, that by a known law of heat, a reduction of the temperature of the cavities must be the consequence. These cavities, being uniformly accustomed to a heat of ninety eight degrees, a reduction of that temperature by a number of degrees, which would have but little influence on the external surface, ever exposed to varying temperatures, may induce debility on the membranes lining the cavities; on which I suppose inflammation to follow on the principles which have been mentioned. I believe the redness, which is observable on the skins of infants a few hours after birth, to be a slight degree of inflammation, and think the sudden change of temperature, to which they have been subjected, is obviously the cause of it.

It is rendered more probable, that this is the true cause of the inflammation of cavities, when exposed to a tempe-

perature much lower than is natural to them, when the extent in which the same principle may be observed to act, in the inferior orders of the animal creation and also in the vegetable kingdom, is taken into consideration.

All that vast number of animals which go into the state of torpor, strongly evince the extensive prevalence of a principle which is beginning to be generally understood and admitted, which is, *That animal matter becomes more sensible to its ordinary stimuli after they have been diminished or withheld for a short time.*

We learn on the authority of Fontana, that vipers which, during the winter had been kept at the temperature of 59 degrees, were destroyed in two minutes by exposing them suddenly to a temperature of 67 degrees; which is very far below that, which they easily bear and in which they are in full vigour during the summer. This fact is clearly in favour of the opinion, that cold has had the effect, on these animals, of rendering them infinitely more sensible to the stimulus of heat, than they were before they had been exposed to cold.

The Abbe Spalanzani observed, that newts conceal themselves in the earth and become torpid in the month of October, when the thermometer generally stands at 54 degrees; after remaining several months in this state, they re-appear in February, when the degree of heat is much less than at the time of their becoming torpid. No one, I believe, contends that there is any physical necessity, from the constitution of these animals, that they should go into the state of torpor; indeed it is known to be otherwise, as the same species of animal will be subject to become torpid in one climate and not in another.* They require a certain quantity of heat to keep them active, and this must be larger at the close of summer, than they can bear at the commencement of spring, furnishing one of innumerable instances, in which it is obvious, that living matter becomes less sensible to stimuli which are frequently repeat-

* Professor Barton's Lectures.

ed. We here find the newts retiring on account of the defect of heat, when it is generally equal to 54 degrees; they continue in their state of torpor, exposed to feeble stimuli, for several months; when, by some change which has taken place in them during the time that they have spent in their winter quarters, they are prepared to come forth in February, when the temperature is frequently below that of freezing. That it is defect of heat which causes them to become torpid is shewn by their remaining active, when kept in warm places; and the change which takes place in the time of torpor, appears to consist in their acquiring a capacity, of having perfect life supported by a less quantity of heat. By which, I mean, the excitability of their systems has been accumulated and great action is produced in them by a slight stimulus.

This principle, so general and so frequently manifesting its influence, could not elude the accuracy and penetration of Mr. Hunter, to whom it appeared in a variety of familiar instances. He avails himself of it, to explain some phenomena, which had not before been plausibly accounted for. He notices the disposition in eels to be so violently affected by a moderate heat applied to them when torpid, as to be destroyed by it in a few minutes. He reports the same effect having been produced on some other animals, as snakes and lizards. On the same principle, he explains the speedy death of birds caught during the winter, and brought suddenly into a warm room.

The immediate destruction of animals passing from a low to a moderate temperature, may, I think, be fairly attributed to the violent action which arises from the heat *suddenly* applied to their very excitable systems, because they become capable of bearing a degree of heat, when applied by the steady and unerring hand of nature, equal and often superior to that which kills them, when afforded by art, without a due regard to their particular states.

The effect of cold in disposing to increased action on the subsequent application of heat, is not confined to ani-

mals, but vegetables may be observed to have a similar effect produced in them, of which a variety of facts present themselves as interesting examples. It is particularly pleasing to notice the existence and influence of a law common to these two great orders of animated creation, forming another chain, by which nature seems to have connected her works. This agrees with the many cogent arguments which have lately been advanced to support the opinion, that a gradation has been observed so regular and insensible, as to preclude the possibility of drawing a line of separation, and even to force us to admit, that there is no point at which animal life can be said to cease, and vegetable life to commence. Which doctrine is rendered almost certain, by the learned investigation, and the able and beautiful vindication which it has received from professor Barton.†

In the vegetable Statics of Dr. Hales, there are some very interesting experiments, by which the effect of cold in predisposing to action is clearly shewn. In the spring, when the temperature is still very little above the freezing point, the sap begins to rise in vines, and the force and rapidity of its motion are observed to be considerably increased by a cold night having preceded a warm day. If the sun rises clear, the sap continues to rise no longer than nine or ten o'clock, after which time, it was observed gradually to subside until evening; which, I think, shews unequivocally that it is not the *heat* alone independently of circumstances which causes the sap to rise, as that is greatest after twelve o'clock. It must, therefore, depend on the irritability or excitability, which is exhausted by the heat acting on it from sunrise until nine or ten o'clock; and the absence of the sun every night suffers the plant to accumulate a stock of excitability for the succeeding day. The irritability of the *hedysarum gyrans* is said to be exhausted

† Lectures on the affinities between animals and vegetables.

by the noon day sun.* And the experiments of Fontana shew that the irritability of the *sensitive plant* is most abundant in the morning, less at mid-day, and almost imperceptible in the evening. It has also been remarked, that corn ripens in countries alternately cold and warm in a much shorter time than in such as are uniformly warm.

These, are only instances, in which the health and growth of vegetables are promoted by the alternation of heat and cold; but there are not wanting others in which, to continue the analogy, mortification and death are the consequences of a transition, too rapid, from the temperature of freezing even to that of a clear morning of spring. All delicate vegetables and the young leaves and fruits of trees, are liable to be blighted after a frosty night. That this arises from the stimulus of the heat of the next day, being disproportioned to the remaining quantity of life, or to the excitable state of the vegetable, and is not the necessary consequence of the frost, is proven, by the mode which has been successfully practised to prevent it; that is, by the simple precaution of moderating the heat by the evaporation which will arise from watering the plants before the rising of the sun.

INDEPENDENTLY of the arguments which are afforded by analogy, drawn from the lower orders of animals and from vegetables; I am countenanced, in the opinion which I have advocated, by the facility with which it applies to a number of cases, which have not been explained on any other principle. One of these cases on which, I repose with great confidence, is that of the lungs, pleura and intercostal muscles being lacerated, by a fracture of the ribs. In this case the air escapes into the cavity of the thorax and into the cellular membrane; here no inflammation

* I have here, as well as in several other places used the facts which have been collected in the third volume of Medical Extracts.

of consequence takes place, although air gets access to the cavity of a shut sac and should, according to Dr. Monro, produce inflammation: This air, is frequently *renewed*, that first taken in, finding its way into the cellular texture, it is also *long continued* in its application, and these according to the opinion of Mr. Abernethy are the two requisite circumstances, for the production of inflammation. I have in another part of this essay endeavoured to shew that imperfection of the cavity, supposed by Mr. Hunter to be the cause of inflammation, could not be denied to exist in this case; and certainly where a laceration of the soft parts has taken place to so great extent, there must be as much irritation as could be desired by Mr. John Bell.

Why inflammation does not occur here, is not satisfactorily explained by either of the writers, who have been mentioned. The reason is immediately obvious, when the theory which I have embraced is attended to, the air in passing through the lungs, the central point of animal heat, must acquire a temperature equal to that of the body; and is thereby rendered unfit, to induce the debility on the cavities, which is necessary to predispose these parts, to take on inordinate action, on the application of so feeble a stimulus as that of their natural heat.*

But if, along with this fracture and laceration, a wound is made through the integuments of the thorax, then the surrounding air gets access to the cavity, without having had its temperature increased, and inflammation arises in the manner which I have already stated.

Nor is this effect of temperature by any means confined to a few cases of unfrequent occurrence; but it may be seen

* It might be contended here, that the air in passing through the lungs is deprived of its oxygen, and thereby rendered incapable of stimulating the cavity of the thorax. A considerable portion of the oxygen which is taken in, in healthy respiration, is well known to be expired in the same state, and this, when the lungs are wounded, must pass unaltered into the cavity of the chest; but we have no grounds on which to found the opinion that oxygen, after getting into the chest, would unite with any thing there, and stimulate that cavity by the heat which would thus be produced: And I am acquainted with no fact, which favours the idea of oxygen possessing more irritating powers than any other gas.

almost daily in the practice of physicians; all catarrhal affections are produced in this way; and the range of this principle, includes all grades of action, from the transitory glow, which we feel in our nostrils, in passing from the cold air, to a warm room; up to the fatal inflammation and gangrene, which take place on the application of heat after long exposure to intense cold.

There can be no doubt, as to the sensibility to the stimulus of heat, being increased by a previous exposure to cold. The pain which is felt on holding the hand near a fire, after having been in the open air on a cold day of winter, or after handling ice, is familiar to every body. Which circumstance, demands the admission of this principle for its explanation; as the same degree of heat would have produced no unpleasant sensation in the hand, if it had not before been in a reduced temperature.

I think it probable, that I have the authority of Mr. Cline to support me in the doctrine which has been contended for in this essay; but of this I am not certain. I recollect, that he attributes the inflammation of wounded cavities to a difference of temperature; but whether he believes the doctrine of cold being a stimulus, or in what he explains its action, I have not learned.

I AM encouraged to adhere to the theory which has been proposed to account for inflammation arising in wounded cavities, by a consideration of the great advantage in practice which may be obtained from its being ascertained to be true. If the lowness of temperature should be proven to be the principal cause of inflammation on internal parts of the body when exposed to it, a number of operations will be performed without hesitation and with safety, which are now declined by surgeons, or undertaken with the most painful dread of the dangerous inflammation which they know must supervene. The manner in which I should

guard against inflammation, consistently with my ideas of its cause, is plain, and immediately presents itself to view; and I flatter myself that the proposition of Dr. Beddoes, to have rooms filled with air, modified in such a way as to suit the diseases of his different patients, will be considered a sort of precedent, and will shield me from ridicule, for suggesting the advantage that would probably result from performing some operations in rooms, of a temperature equal to that of the human body.

The operations which would thus become less dangerous, are all those in which it is necessary to make an opening into any of the large cavities of the body, for the discharge of substances contained in them, as in operations for empyema, and those for the discharge of extravasated blood, and any viscid or solid matter from the abdomen; also, all the cases in which the cavities of joints are opened for the removal of fluids or cartilaginous bodies; and the operations for hernia when it is necessary to lay open the sac. A mode of preventing inflammation on the exposed bowels in operations for hernia, which is pointed out by Professor Wistar, gives a tacit acknowledgment of the truth of the doctrine which has been advanced in this enquiry. He recommends bladders of *warm* water to be put on the intestines, which are unavoidably exposed in the operation: He has found this practice useful; its use could not be that of preventing air from touching the bowels, because no care could obviate it, besides it has been shewn, that air is not injurious to parts naturally defended from it. In these cases, I suppose, the heat of the water prevents the peritoneum from falling into that state of debility which would be followed by inflammation on the principles which have been advanced. To these, may perhaps be added, the operations for the discharge of large collections of pus.

The success of Mr. Abernethy's mode of discharging the matter of lumbar abscesses, may, I believe, be attributed to the smallness of the punctures and their immediate

closure, which prevent the temperature of their cavities from being reduced, and thereby obviate inflammation; the simple operation of paracentesis is successful for the same reason.

The cause of hectic fever consequent on opening lumbar abscesses and other collections of purulent matter, being entirely unknown; I may be allowed to venture a conjecture, that hectic fever is in no other respect different from the ordinary constitutional derangements arising from local inflammation except that which depends on the health of its subjects being injured by previous suppuration. It is, I believe, on the same principle that the causes which produce inflammatory fevers in well-fed and healthy men, give rise to typhus fevers in sailors, soldiers, and poor persons who are debilitated by having been badly fed and crowded together in confined situations, as on board ships, in jails, and in the miserable habitations of the indigent. In one case, debility is brought on by a tedious and distressing suppuration; in the other, by an habitual destitution of the necessary supply of food, &c. debility is also induced; which debility is of a chronic nature; and this, according to Professor Rush, expends the excitability of the system, leaving it in a state, in which stimuli generally act with too little force upon it to excite in it the commotions of (inflammatory) fever.†

Two other operations, which are so formidable as to intimidate the most intrepid operators, deserve the greatest attention from surgeons, and any proposition which affords the slenderest hope of their terrors being diminished, claims a candid consideration from those, whose standing in the profession entitles them to discountenance, or to admit and encourage any innovation, proposed as an improvement.

One of the operations to which I allude, is the extirpation of scirrhus and dropical ovaries. I do not know that this operation has ever been performed, and as I had

† Medical Enquiries and Observations, vol. IV. p. 127.

no authority to support me, I had scarcely dared to whisper my opinion of its feasibility, until I found it had been proposed a long time since by the venerable Dr. Shippen, professor of anatomy in this University. There is certainly nothing in the anatomy of the parts, which should deter surgeons from removing them, when from disease they have become incapable of performing their office, and endanger life, or at least render it uncomfortable. We do not hesitate to take out cancerous eyes and scirrhous testes when such sacrifices are necessary to preserve the lives of our patients. And, however strongly prejudice might oppose this practice in its commencement, I believe it would be submitted to, when the nature of the case, and the slight permanent inconvenience which would be the consequence of the loss of one ovary, was fully comprehended. All surgeons sometimes witness the pain, anxiety, and despondency which are concomitants of these affections. The unhappy subjects of them despairing of a recovery, calculate on spending their lives in a state of wretchedness and disease. Under these circumstances, no alternative however painful, which gives a prospect of health, would be rejected.

The urgency of the cases, and the rapid manner in which they hasten to a fatal termination; have compelled surgeons, to turn their attention to the distresses of parturient women; who from malconformation, cannot be delivered in the natural way. For their relief, an operation has been occasionally performed, called the Cæsarian section which is perhaps the most dangerous one in surgery. A larger proportion of the persons who have been the subjects of it, have died, than of those who have borne any other accredited operation. The danger of this practice being considered, it is doubtless much to be desired that it could be dispensed with, this, however, seems impossible, and all that can be done, is to deprive it, of every portion of danger, which is not inseparable from it, and intimately connected with the parts which are the subjects of operation.

I know not, in what manner, the irritability of the uterus is to be estimated; and am therefore, unable to decide, what degree of inflammation would arise from an incision made into it; I presume, that a wound made in this part would be equally liable to become inflamed from irritation, as one, made in any other muscular part of the body. But as the influence of temperature, is so obvious, in causing increased action and inducing inflammation, mortification and death in living matter, it is at least probable, that the fatality which has almost uniformly followed this operation, may in some degree, depend on the exposure of the cavity of the abdomen, and its contents, during the operation. This operation therefore, which has heretofore been almost always only a prelude to death, has an indisputable claim to be performed in rooms of the temperature of 98 degrees. The danger cannot be augmented by it, but may possibly be diminished.

Among the very few instances of this operation being successfully performed, there is one reported by Dr. Moseley as occurring in the West Indies; a young negro woman, who was in labour, becoming impatient of the pain which she suffered, conceived the idea of relieving herself in a summary way, and with a common knife made an incision into the abdomen and uterus, through which the child was delivered. The intestines which had protruded through the wound, were replaced along with the placental portion of the funis, by some person at hand, and a stitch or two were put into the wound. The medical attendant, who soon after arrived, suspecting that some dirt or other matter had been thrust into the abdomen along with the intestines, took them out, examined and returned them, and at the same time extracted the placenta through the wound. This patient recovered, although almost every circumstance conspired to make the case peculiarly violent; the incision was made with a rough instrument, and the bowels handled and exposed much more than would have been necessary in a regular operation. As this case terminated favour-

ably, under so untoward circumstances, it is fair to conclude that it ought to be attributed to something else than chance, and I can conceive no circumstance to which it may with so great probability be ascribed, as to the heat of the weather in that climate, increased probably by a still more heated cabin.

Mr. John Bell mentions a curious case of a soldier being wounded in the side by a halbert, afterwards walking a mile with his intestines hanging out, wrapt in the skirts of his shirt, and deposited in his hat: The roads were dusty, and the intestines dry as parchment and blackened with dust, when he obtained the assistance of a charitable old lady, who bathed his intestines with warm milk, and replaced them. It must be observed, that "the weather, it being mid-summer, was intensely hot." Here it appears that neither the dust nor other irritation was capable of exciting a fatal inflammation, which, I think, would certainly have been the consequence of exposure, so long continued, to A LOW TEMPERATURE.

When I resolved to write on this subject, I flattered myself with the idea, that I should be able to prove the truth of my opinions, but was obliged to relinquish a series of experiments which I had conceived for that purpose, by the unfavourableness of the season of the year, in which only, I had an opportunity of attending to the subject, and for the want of several conveniencies which are indispensable to accuracy and success in experimenting. It is, however, pleasing to me, to reflect that the truth or fallacy of my explanation, is capable of being ascertained with absolute certainty; and I hope it will be deemed worthy of examination, by some abler hand and more experienced experimentalist.

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